TECHNICAL NOTE

Bedside vena cava filter placement with intravascular ultrasound: A simple, accurate, single venous access method

Donald L. Jacobs, MD, Raghunandan L. Motaganahalli, MD, and **Brian G. Peterson, MD,** *St Louis, Mo*

Two techniques of vena cava filter placement with intravascular ultrasound (IVUS) guidance have been described previously. Placement with real-time IVUS imaging requires two venous access sites, one for the filter delivery system and one for the IVUS catheter, which makes the procedure more invasive. Alternatively, a single-access technique of IVUS imaging of the vena cava requires measuring the distance from the access site to the desired location for filter placement and then delivering the filter to that distance blindly, risking filter misplacement. We describe in this article a single puncture technique that allows for real-time imaging to position the filter delivery sheath using IVUS and reduces the uncertainty of the blind positioning of the filter delivery system. (J Vasc Surg 2007;46:1284-6.)

Intravascular ultrasound (IVUS) guidance for inferior vena cava (IVC) filter placement was initially described in 1999 as a replacement to contrast venographic imaging as an adjunct to fluoroscopy.[1,2] IVUS as the sole imaging method has since been demonstrated to be effective and accurate for filter placement.[3-5] The ability to place caval filters with complete caval imaging in the intensive care unit (ICU), without transporting the patient to an angiography suite or the operating room, has been proposed as safer and more cost-effective by avoiding patient transfers and angiography suite/operating room costs.[3,4]

Despite these advantages and the widespread availability, portability, and increasing familiarity with IVUS, the acceptance of IVUS-guided filter placement has been limited. The primary criticisms of the technique include the need for two sites of venous access for real-time imaging to position the filter deployment system, and the possibility of inaccurately mapping the cava by measuring the length from the puncture site to the filter location and then placing the filter delivery catheter or sheath to that position after removal of the IVUS catheter. Some consider the later technique requires a "leap of faith" that the delivery system is accurately positioned at the time of deployment.

To alleviate the concerns with these techniques, we describe a novel, single-puncture technique that provides confidence in the positioning of the filter delivery system without the need for a second venous access for IVUS imaging. This is accomplished by utilizing the echogenic shadowing of the IVUS image by the radiopaque tip of the filter delivery sheath to precisely place the filter delivery sheath at a point just below the renal veins, then maintaining that position while removing the IVUS catheter and delivering the filter to the sheath tip for deployment.

Evaluation of eight different filters revealed that three commercially available filters and their delivery systems—the Trapease and Optease filters (Cordis Corp, Miami Lakes, Fla) and the Günter-Tulip filter (Cook Inc, Bloomington, Ind)—are uniquely well suited for this particular method of IVUS-guided filter placement.

PROCEDURAL TECHNIQUE

After femoral vein puncture, the delivery sheath for the filter is placed over the wire a few centimeters into the femoral vein. If placing a Trapease or Optease filter, the 6F 55-cm Brite Tip sheath (Cordis Corp) packaged with the filter is not used. Instead, an 8F 55-cm Brite Tip sheath is placed to accommodate the 8F, 12.5-MHz IVUS catheter (Volcano Therapeutics, Rancho Cordova, Calif) and to provide an echogenic tip for proper positioning of the sheath. The Optease and the Trapease filters are both delivered through the 8F sheath in a manner identical to that used with the 6F sheath.

Once the sheath is placed in either femoral vein, the IVUS catheter is then advanced through the iliac veins, the IVC, and the suprahepatic cava, until cardiac motion is seen. If the wire tracks into a branch vein, the IVUS catheter can be used to define this and allow accurate retraction and redirection. Once cardiac motion is seen, confirming passage to the atrium, the IVUS catheter is then slowly retracted, delineating the anatomy during with-

From Department of Surgery, Division of Vascular Surgery, St Louis University School of Medicine.

Competition of interest: Dr Jacobs has received speaking honoraria and consulting fees from Cordis.

Reprint requests: Donald L. Jacobs, MD, St Louis University, Department of Surgery, Division of Vascular Surgery, 3635 Vista Ave, PO Box 15250, St Louis, MO 63110-0250 (e-mail:jacobsmd@slu.edu.)

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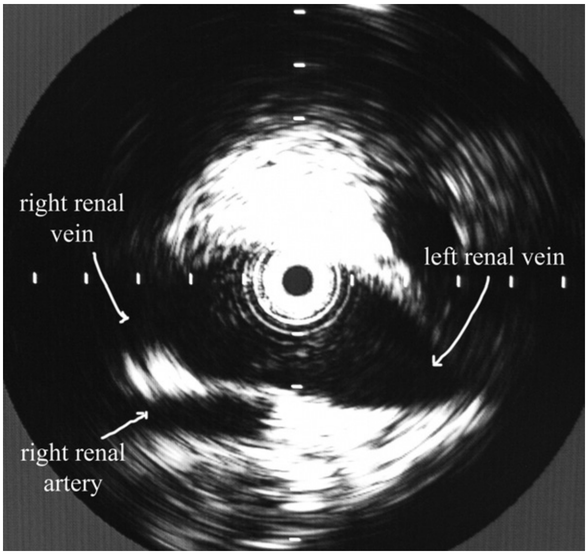

Fig 1. An intravascular ultrasound image shows the vena cava at the lower edge of the origin of the renal veins with the right renal artery crossing posteriorly. This is the desired location to which the filter delivery sheath tip should be positioned for ideal filter placement.

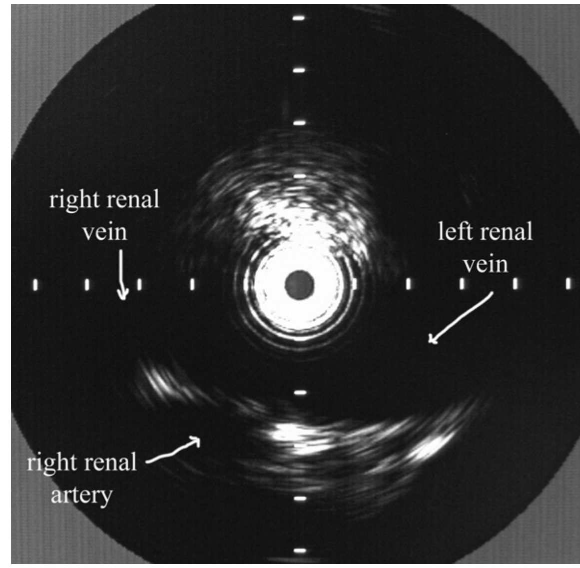

Fig 2. An intravascular ultrasound image at the same level in the inferior vena cava as Fig 1 shows the decreased ultrasound penetration from the shadowing effect of the sheath and its radiopaque tip. This demonstrates that the sheath is in the desired position in the inferior vena cava for accurate delivery of the filter.

drawal. This ensures the complete imaging of the IVC and also provides added accuracy in locating the renal veins.

The anatomic location of the renal veins is aided by the visualization of the right renal artery passing behind the cava, typically just below the level of the renal veins (Fig 1). The renal veins are typically 35-40 cm from the femoral vein access. The iliac confluence is usually 15 to 20 cm proximal to femoral access.

Once the IVUS is positioned at or just below the lowest renal vein, the 8F Brite Tip sheath is then advanced over the IVUS catheter until the radiopaque tip shadows the ultrasound image of the IVUS catheter (Fig 2). The tip of the sheath may be repeatedly passed across the IVUS transducer while maintaining the position of the IVUS catheter to reproduce the shadowing and confirm the placement of the sheath tip at the level of the transducer in the IVC just below the renal veins.

The sheath is then held in that position while the IVUS catheter and wire are removed and the filter is passed into position. The Trapease or Optease filter is placed into the 8F sheath and advanced with its standard blunt-tipped obturator until the mark on the obturator shaft is at the diaphragm of the sheath, indicating that the filter is now positioned with the top of the filter at the tip of the sheath. The sheath has been held fixed in position just below the renal veins, and the filter is therefore in the correct position for deployment. The obturator is then held secure with slight forward pressure while the sheath is withdrawn in a "pin-pull" fashion to deploy the filter. Filter position can then be confirmed with a plain abdominal radiograph. Alternatively, filter position can be confirmed with IVUS by careful reinsertion of the catheter and wire.

To facilitate imaging of the filter with IVUS, the wire is extended only 3 to 4 cm beyond the IVUS catheter tip, and any resistance to its passage is interrogated by passing the IVUS to the wire tip. This allows for retraction and redirection. If there is concern about manipulation, confirmatory imaging with x-ray is recommended.

For placement of the Günter-Tulip filter, the steps are the same except there is no need to upsize the sheath for the IVUS catheter given the 9F inner diameter of the delivery sheath provided with the femoral access Günter-Tulip filter set. After full imaging of the IVC and positioning of the echogenic sheath tip below the renal veins, the sheath position is maintained and the IVUS catheter and wire are removed. The preloaded filter and introducer shaft is placed into the sheath and the Tuohy-Borst valve is secured to the sheath end. The filter introducer shaft is then advanced until the distal mark on the shaft is at the Tuohy-Borst valve, indicating that the tip of the filter is at the tip of the sheath. The filter delivery shaft is then held secure while the sheath is pulled back to the proximal mark on the shaft uncovering the filter. The filter is released in its standard fashion by securing the position of the system from the end pin vise and loosening the red hub and pulling back toward the end pin vise.

RESULTS

In the 3-year period from August 2003 to July 2006, a single surgeon (D. L. J.) placed 199 IVC filters. IVUS was used to place 75 filters (38%), and 37 (49%) were placed using IVUS-guided filter placement as described in Procedural Technique. Trapease and Optease filters were used in

72 patients (96%), and Günter-Tulip filters were used in three patients (4%).

Indications for filter placement were not altered when IVUS-guided placement was used. No contraindications to the use of IVUS were defined other than the need for venous access above the diaphragm. All but one case was done with femoral access. The one case done from jugular access was difficult because of the need to pass the wire through the atrium to the IVC without fluoroscopy, as IVUS guidance is not helpful in that maneuver. Two filter misplacements occurred early in our experience, one due to an inaccurate measurement and one due to misinterpretation of the IVUS imaging. Both misplacements occurred while the originally described IVUS-guided technique was being used, and both resulted in common iliac vein deployment of a Trapease filter. In both patients an additional filter was placed above the malpositioned filter. No mal-deployments have occurred since we changed to the new technique.

DISCUSSION

The usefulness of beside placement of caval filters has been established, but the imaging technique best suited for this has been debated. IVUS has been shown to be an accurate method to guide filter placement in several series.[3-5] Indeed, Ashley et al[6] showed IVUS to be superior to contrast venography in accuracy of imaging used during vena cava filter placement.[6] Yet the utilization of IVUS for filter placement has been limited by techniques for IVUS filter placement that are viewed as difficult or inaccurate, or both. The single venous access method described here eliminates the need for the two sheaths required for real-time imaging of the filter delivery system. This makes the procedure simpler and may reduce the risk of venous access site thrombosis. The mapping and measuring method previously reported by Matsumura et al[4] and used in our initial experience has a reported accuracy of 92%. The technique can be difficult to execute with confidence, however, and is susceptible to errors in filter positioning that are largely eliminated in the simplification that we report here.

The technical success rate with IVUS-guided filter placement reported in this series using the new technique was 100%, but experience with IVUS is essential for good results. To adopt this technique, we recommend that fluoroscopic imaging be combined with IVUS in the operator's early experience. This will allow the operator to correlate accuracy of IVUS imaging of the IVC and localization of the renal veins with contrast venography, as well as demonstrate the stability and accuracy of filter deployment after delivery sheath positioning as it occurs using the IVUS-guided technique alone.

Confirmation of filter placement with IVUS with repeat IVUS imaging is now our standard technique, but it is recommended that x-ray confirmation be done if there is any concern about manipulation through the filter after placement, or if there is any concern about the definition of the caval anatomy. It is possible that misinterpretation of the caval anatomy during filter placement would be replicated on repeat IVUS imaging to confirm filter placement, resulting in lack of recognition of a mal-deployment.

The use of IVUS for filter placement is the most frequent use of IVUS in our practice. The added cost of the IVUS catheter has been a concern for some, but the procedure has been shown to be cost-effective by saving on staff and resource utilization in the angiography suite.[4] Efficiency and ease of scheduling have been added advantages of IVUS-guided filter placement at our institution.

Although all of our experience has been with the Volcano Therapeutics IVUS catheters and console, other IVUS platforms such as the Galaxy system (Boston Scientific, Natick, Mass) should be applicable as well using their 8F 15-MHz catheter for cava imaging and sheath positioning. The filter delivery systems of the Trapease/Optease filters and the Günter-Tulip filter are well suited for this technique.

We have evaluated five other commonly used filters. Some are delivered in a method that does not depend on the exact sheath position. Others are delivered in a sheath too small for the IVUS catheter, and drag from partial filter expansion in a larger sheath precludes upsizing for IVUS. These other filters can all be placed with the alternative IVUS-guided techniques.

As the need for vena cava filters in ICU patients has increased, the usefulness of techniques for bedside filter placement has increased as well. The simple modification in technique described here should prove useful to physicians already using IVUS-guided filter placement. We encourage others to consider adopting IVUS as the imaging modality of choice to guide safe and accurate bedside caval filter placement.

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